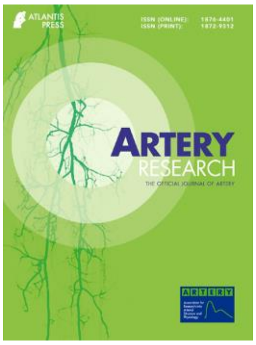

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P.042: MULTIAXIAL MECHANICAL CHARACTERISTICS OF CAROTID PLAQUE: ANALYSIS BY MULTI-ARRAY ECHOTRACKING SYSTEM.

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P.039
A MODIFIED AUGMENTATION INDEX (AIX) USING WAVE INTENSITY ANALYSIS

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Augmentation index (AIx) is widely used as a measure of wave reflection in clinical studies. The validity of AIx results rests on the ability to quantify the magnitude of the reflected pressure wave (P_-) in relation to the pressure pulse (PP), and this is traditionally carried out by determining the inflection point (Ip) on the pressure waveform. In this study we investigate the results of AIx and propose a modified augmentation index (mAIx) that is more sensitive to loading conditions.
In 11 anaesthetised dogs, total sequential occlusions were produced at 3 aortic sites (thoracic, diaphragm, abdominal), and at the left iliac artery. Pressure and flow were measured in the ascending aorta before and during the occlusion at each site, and Ip was ascertained using the 4th derivative of the pressure waveform allowing for the determination of AIx. Magnitude of P_- was calculated using wave intensity analysis (WIA), and divided by PP giving a modified Augmentation index (mAIx = P_-/PP).
AIx during control were surprisingly not different from those determined during proximal occlusions. However, P_- increased significantly during occlusions; resulting in a significant increase in mAx by 165% during thoracic, 48% during diaphragm and 20% during abdominal occlusions, all compared to control.
The Ip is not an accurate method for determining P_-. This can result in significant errors in the estimation of AIx. The mAIx, derived from pressure-flow relationship in the wave intensity analysis is more sensitive to the determination of P_-, than AIx which uses only the pressure waveform.

P.040
INCREASED CAROTID INTIMA-MEDIA THICKNESS PREDICTS HIGH CARDIOVASCULAR RISK

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Objectives: The aim of this study was to investigate the relationship between the total cardiovascular risk assessed by SCORE system and vascular markers: carotid intima-media thickness (IMT), arterial stiffness indices, brachial artery flow mediated dilatation (FMD) and the ankle-brachial pressure index (ABI).
Background: Carotid IMT, arterial stiffness indices, FMD and ABI are markers of subclinical atherosclerosis. The SCORE risk system offers direct estimation of ten-year total fatal cardiovascular (CV) risk. The relationship between these markers and SCORE risk has not been investigated.
Methods: We studied 160 subjects without cardiovascular disease (aged 49.91±7.16 years, 69 males). Traditional risk factors, carotid IMT, carotid-radial pulse wave velocity (crPWV), stiffness index (SI), measured by photoplethysmography, brachial artery FMD and the ABI were assessed. Laboratory tests included serum lipid and glucose profile. The total CV risk was evaluated by SCORE system.
Results: By multivariate analysis carotid IMT ($p < 0.001$) and SI ($p = 0.008$) were correlated with SCORE risk. Brachial artery FMD, ABI and crPWV didn't correlated significantly with SCORE risk ($p = 0.052$, $p = 0.110$ and $p = 0.937$ respectively). In stepwise regression models that include carotid IMT, crPWV, SI, FMD and ABI, only carotid IMT $\geqslant$ 0.9 mm correlated with high total CV risk (SCORE $\geqslant$5%). Odds ratio for increased CV risk was 8.56 (CI 95% 3.109–23.567). The IMT cut-off point at 0.9 mm predicts high CV risk (sensitivity 67.4%, specificity 78.6%).
Conclusions: Carotid artery IMT and arterial stiffness marker SI predict total CV risk. Carotid IMT is a prognostic marker for high CV risk.

P.041
VALIDATION OF SPHYGMOCOR-PROCESSED AUGMENTATION INDEX USING CAROTID ARTERY DISTENSION WAVEFORM

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Arterial tonometry (AT), used for measurement of augmentation index (AI) at the central level, has been criticized because of artefacts induced by hand motion and deformation of the artery. We hypothesized that carotid distension waveforms, obtained with high definition echotracking device (walltrack system WTS-AI) could be used to derive augmentation index, a measure of wave reflection, and that those values were comparable with AT, either performed at carotid (CSP-AI) or on the radial artery (RSP-AI), using the generalized transfer function (GTF) of Sphygmocor system.
A group of 48 subjects with various diseases was studied. For WTS-AI, inflexion point was determined from the 0 crossing of the 3rd derivative. For CSP and RSP-AI, standard reports of Sphygmocor were used. WTS-AI could be determined with good precision from all tracings in all patients. Agreement between WTS-AI and CSP-AI was good ($R^2 = 0.83$, RMSE = 5.8), with a 35% systematic underestimation by Sphygmocor: slope = 0.65 [0.56–0.73]). A weaker agreement between WTS-AI and RSP-AI was observed ($R^2 = 0.71$, RMSE = 6.9), with comparable underestimation. This underestimation was not due to GTF, but to the applanation process since bypassing GTF had no influence on it and because AI, estimated with another type of tonometer, was correctly scaled with CSP-AI (slope 0.93 [0.81–1.05). CSP-AI and RSP-AI were not in good agreement ($R^2 = 0.66$, RMSE = 10.7), but correctly scaled (slope = 0.87 [0.81–1.05].
In conclusion, wave reflections can be assessed from distension waveforms with good accuracy. Lower values for AI resulted from overestimation with applanation techniques rather than from underestimation with distension waveforms.

P.042
MULTIAXIAL MECHANICAL CHARACTERISTICS OF CAROTID PLAQUE: ANALYSIS BY MULTI-ARRAY ECHOTRACKING SYSTEM.

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Carotid plaque rupture depends on the various types of mechanical stresses. Our objective was to determine the multiaxial mechanical characteristics of atherosclerotic plaque and adjacent segment of the common carotid artery (CCA).
A novel non-invasive echotracking system was used to measure intima-media thickness, diameter, pulsatile strain, and distensibility at 128 sites on a 4 cm long CCA segment. The study included 62 patients with recent cerebrovascular ischemic event and either a plaque on the far wall of CCA (n = 25) or no plaque (n = 37). The mechanical characteristics of the carotid segment devoid of plaque did not differ between the two groups. Among patients with plaque, 16 had a larger radial strain at the level of plaque than at the level of adjacent CCA (pattern A: outward bending strain). The 8 patients who had an opposite pattern (inward bending strain) were more often dyslipidemic (100% *vs* 56% P = 0.03) and type 2 diabetic (63% *vs* 12%, P = 0.04) than pattern A patients. Strain gradient significantly decreased in parallel with the presence of dyslipidemia and/or type 2 diabetes. Longitudinal gradients of distensibility and Young's elastic modulus were consistent with strain gradients.
In conclusion, type 2 diabetes and dyslipidemia were associated with a stiffer carotid at the level of the plaque than in adjacent CCA, leading to an inward bending stress. The analysis of plaque mechanics along the longitudinal axis may afford useful information, since repetitive bending strain of an atherosclerotic plaque may fatigue the wall material and result in plaque rupture.

P.043
APPLICATION OF WOMERSLEY THEORY: ESTIMATION OF PULSE VOLUME FLOW AND WALL SHEAR STRESS IN LARGE ARTERY USING ULTRASOUND

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In order to assess pulse volume flow (PVF) and wall shear stress (WSS) in large arteries by the means of ultrasound, a Womerlsey theory based iterative method is proposed. Firstly, the PVF is computed by integrating the estimated velocity profiles obtained from multi-gate ultrasound Doppler; the vessel diameter was assessed through M-mode ultrasound. Secondly, an algorithm was applied in order to determine the PVF that gives the optimal fit of the core velocities estimated by ultrasound to the ones obtained through Womersley theory applied for tubes with none moving walls. The WSS is consequently computed from the fitted Womerlsey profiles. The PVF and WSS obtained through this method were compared to the ones given by Poiseuille theory. The method was applied on measurements performed on the brachial artery, repeated at least three times, of 9 presumed healthy volunteers. The results displayed a large relative difference in average maximal PVF (27±7%, $p < 0.01$) and WSS (72±36%, $p < 0.01$), the intra individual variations being 4±9% for the PVF and 11±6% for the WSS. In the case of the mean